DEPARTMENT OF CONSERVATION

Managing California's Working Lands

DIRECTOR'S OFFICE

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July 22, 2013

The Honorable Fran Pavley
California State Senate
State Capitol, Room 4035
Sacramento, CA 95814

The Honorable Wesley Chesbro
California State Assembly
State Capitol, Room 2141
Sacramento, CA 95814

Dear Senator Pavley and Assemblymember Chesbro:

Thank you for the opportunity to provide your committees with information on oil and gas well stimulation techniques at the joint hearing on June 18, 2013. I also want to thank you for your patience in providing me with additional time to prepare a response to the questions in your May 30, 2013, letter. I have often communicated my committment to transparency, communication, and professionalism, so I appreciate being able to take the time to prepare a thoughtful and more complete response.

The enclosed document provides brief descriptions of physical and chemical well stimulation techniques, a list of the types of chemicals used, and what kind of information the Department currently has on the practice in California. As I explained to you when we met prior to the hearing, we do not have specific information on well stimulation operations in a searchable database, nor do we have the resources to dedicate to review thousands of scanned documents. The Department is working toward developing more electronic reporting so that this kind of information may be available in the future.

I hope the information provided is informative, and I look forward to future conversations with you as we continue to update our regulations. If you have any questions regarding the enclosed response, please contact me or Marni Weber, Assistant Director, Office of Governmental and Environmental Releations, at (916) 445-8733 or marni.weber@conservation.ca.gov.

Sincerely,

Mark Nechodom
Director

Enclosure

cc: John Laird, Secretary of Natural Resources
Garreth Elliot, Legislative Secretary
Martha Guzman-Aceves, Deputy Legislative Secretary
Cliff Rechtschaffen, Senior Advisor
Marni Weber
Tim Kustic

Department of Conservation
Response to May 30, 2013 Request from Senator Pavley and Assembly Member Chesbro on Well Stimulation Techniques

1. **What is the division's definition of well stimulation as distinct from enhanced oil recovery and well completion techniques? Please include a description of when well stimulation and well completion activities occur during the drilling or re-drilling of oil and gas wells and what types of wells would receive well stimulation and well completion treatments.**

   Although it is a distinction that has always been made, DOGGR regulations do not define "well stimulation" or "enhanced oil recovery." One of the Division's goals for the hydraulic fracturing rulemaking it to clarify this distinction in regulation. To that end, the Division will be reviewing publications and practices to capture the broadest possible definition/interpretation of "well stimulation." Generally speaking, enhanced oil recovery involves sustained or continual injection over a long period to add fluid to a zone, and well stimulation involves a one-time application of relatively short duration with the goal of opening pores or channels in a zone.

2. **What are the different types of well stimulation used in California? Please provide a comprehensive list.**
   Since the Division does not have well stimulation data captured in a database, the range of specific well stimulation techniques that are being used in California is not readily available from the Division at this time. Below we provide a list of some techniques that are typically used for well stimulation, many of which are found in daily records of activity annotations in individual well files submitted to the Division on a regular basis.

   Enzyme
   Enzyme technology is frequently used for wells that have been in operation for a long time or have conditions in the formation that cause deposits that prevent oil from flowing. The enzymes release these deposits and create an enzyme-water surface that causes an increase in the flow of fluids to the well with a corresponding increase in oil production.
   Chemicals and/or active ingredient(s): Enzymes: protein-based catalysts

   Fracture acidizing
   In fracture acidizing treatments, fluid is injected into the formation under pressure sufficient to cause a fracture, and the acid etches the faces of the fracture to create a channel. This technique is similar to hydraulic fracture stimulation in

that pressures are done at the fracture gradient of the hydrocarbon bearing formation to create the fractures. It differs in that proppants are not used.
Chemicals and/or active ingredient(s): Hydrochloric acid or muriatic acid, commonly used as a swimming pool chemical and cleaner, helps dissolve minerals and initiate cracks in the rock. Acetic or formic acid are also used, however, these are more expensive so they are not as common as other acids.

Matrix acidizing
This process is similar to fracture acidizing except it is performed below fracture pressure and is used to dissolve channels to create wormholes near the wellbore. Use of this technique is highly dependent on the type of rock in the formation and its chemisty.
Chemicals and/or active ingredient(s):Hydrochloric, Hydrofluoric, Acetic, Formic, Sulfamic, or Chloroacetic acids.

Frac Packing
The frac-packing technique combines a hydraulic fracturing process with a gravel pack. The gravel pack helps prevent formation sand from obstructing the well bore, damaging equipment, and having to dispose of it after separating out the hydrocarbon resource.
Chemicals and/or active ingredient(s): Fracking fluid mixtures, gravel.

Gas Lift
Gas lifting is a well stimulation technique that can be used to get the flow started or to repair a well that has a buildup of heavy substances that diminishes or prevents oil from flowing to the surface. This technique typically involves the circulation of nitrogen using coiled tubing inserted down the production string inside the wellbore. Sometimes, this is only done to get the flow started, after which the circulation of nitrogen is ceased. In other cases, the same technique can be used to lift heavy substances, such as chemical scale reducers or water that have settled in the bore and blocked the flow of hydrocarbons.
Chemicals and or active ingredient(s): Nitrogen

Wellbore Cleanout
Wellbore cleanout is performed to clean production casing and tubing by removal of paraffin, scale, and other wellbore blockages to maximize well production.
Chemicals and/or active ingredient(s): Usually mechanical devices such as brushes, scrapers, and other mechanical devices are used. A jetting nozzle may be used with water (which may be heated) or steam to clean the inside surface of the production casing.

3. **What is the procedure the division uses to review, approve or reject, and track the use of well stimulation treatments?**

   DOGGR regulations and oversight focus on the critical requirement of proper well construction and operation. This is to ensure that all fluids (not just the rare well stimulation fluids) moving out of or into the targeted reservoir remain confined to the well bore casing (steel pipe) and the hydrocarbon zone. Therefore, the construction and operation of the well is DOGGR's "permitting event" rather than the drilling well stimulation treatment. When permitting well drilling and construction, Division engineers review items including but not limited to:

   - Operator's proposal for compliance with well construction standards.
   - Geological setting to ensure correct oil, gas, and freshwater zones are identified and their protection is adequately addressed.
   - Well location relative to surface developments (i.e., roads, structures, etc.). This determines needed safety equipment.
   - Compliance with local zoning/permitting requirements.
   - Whether the operator has complied with any orders issued by the Supervisor.
   - Status of bonding (financial assurance) for the proposed well.

   A subset of these items is reviewed before an operator proposes "well rework," which is a separate "permitting event."

4. **What is the extent to which well stimulation is used, including the number and location of wells?**

   The Division has sporadic documentation in well files on well stimulation since the Division does not currently require operators to report well stimulation activities separately. This data is not captured in a specific electronic data field. Therefore, extensive file reviews and surveying of the oil and gas industry would be necessary to accurately capture the extent of current practices.

5. **What are the chemicals used in well stimulation treatments and how is this information disclosed to and tracked by the division? Please provide a comprehensive list.**

   Disclosure of well stimulation treatments is not required at this time, therefore the Division does not track the chemicals used. Based on information we have found related to the various techniques identified above, below is a list of the chemicals

associated with those techniques. This is not a comprehensive list, and further discussions with industry will be necessary to provide the requested information.

The following list is broken down into biocides, breakers, clay stabilizers, corrosion inhibitors, crosslinkers, friction reducers, gelling agents, iron stabilizers, non-emulsifiers, pH adjusting agents, scale inhibitors, and surfactants.

Biocides control bacterial growth and include:
Glutaraldehyde
Quaternary Ammonium Chloride
Tetrakis Hydroxymethyl-Phosphonium Sulfate

Breakers reduce the viscosity of specialized treatment fluids such as gels and foams and include:
Ammonium Persulfate
Sodium Chloride
Magnesium Peroxide
Magnesium Oxide
Calcium Chloride

Clay stabilizers prevent the migration or swelling of clay particles in reaction to water-based fluids and include:
Choline Chloride
Tetramethyl ammonium chloride
Sodium Chloride

Corrosion inhibitors protect iron and steel components in the wellbore and treating equipment from the corrosive treating fluid and include:
Isopropanol
Methanol
Formic Acid
Acetaldehyde

Crosslinkers create a viscous gel used in some stimulation or pipeline cleaning treatments and include:
Petroleum Distillates
Hydrotreated Light Petroleum Distillates
Potassium Metaborate
Triethanolamine Zirconate
Sodium Tetraborate
Boric Acid

Zirconium Complex
Borate Salts
Ethylene Glycol
Methanol

Friction reducers reduce the friction forces experienced by tools and tubes used in the wellbore and include:
Polyacrylamide
Petroleum Distillates
Hydrotreated Light Petroleum Distillate
Methanol
Ethylene Glycol

Gelling agents are chemicals that have properties to bind and react with oil, forming a gelled substance, and include:
Guar Gum
Petroleum Distillate
Hydrotreated Light Petroleum Distillates
Methanol
Polysaccharide Blend
Ethylene Glycol

Iron stabilizers are used to prevent precipitation of iron compounds during acid stimulation treatments and include:
Citric Acid
Acetic Acid
Thioglycolic Acid
Sodium Erythorbate

Non-emulsifiers minimize or prevent formation of an emulsion, are used to aid separation of oil from an aqueous emulsion (or wtery mix of oil and other hydrocarbonsubstances), and include:
Lauryl Sulfate
Isopropanol
Ethylene Glycol

pH adjusting agents adjust the pH or relative acidity of fluid to maintain the effectiveness of other components, such as crosslinkers, and include:
Sodium Hydroxide
Potassium Hydroxide
Acetic Acid

Sodium Carbonate
Potassium Carbonate

Scale inhibitors are used to control or prevent scale deposition in the production conduit or completion system and include:
Copolymer of Acrylamide and Sodium Acrylate
Sodium Polycarboxylate
Phosphonic Acid Salt

Surfactants behave like soap and lower the surface tension or interfacial tension between fluids or between a fluid and a solid and include:
Lauryl Sulfate
Ethanol
Naphthalene
Methanol
Isopropyl Alcohol
2-Butoxyethanol

6. **How many inspections of well stimulation treatments does the division perform annually?**

Although DOGGR field staff witness and document tens of thousands of oilfield operations per year, well stimulation is not a specific data category that is captured. Once the scope of well stimulation activities that warrant separate review or data capture is defined, DOGGR can update data management systems to capture well stimulation inspections.

7. **How much and what kind of specific training do division staff receive in order to effectively monitor, inspect and regulate well stimulation treatments?**

Operators have been using well stimulation techniques in California since the 1880s. Once the broad scope of well stimulation activities is defined, and it is determined which activities need oversight by the Division, the Division will consult with other regulatory agencies to ensure all regulations, requirements, and any necessary training are addressed.

8. **Are well stimulation treatments used in conjunction with enhanced oil recovery techniques?**

Well stimulation operations can be focused solely on the wellbore or on the reservoir; they can be conducted on old wells and new wells alike; and can be designed for remedial purposes or for enhanced production. For instance, a

production well in an enhanced oil recovery (EOR) program might be stimulated by hydraulic fracturing or other well stimulation techniques to increase the effectiveness of nearby injection wells whose purpose is to increase flow out through the production well.

9. How much water, and from what sources, is used in well stimulation treatments?

The quantity of industry's water acquisitions is beyond the scope of the Division's regulatory sphere and therefore not captured as a data point. However, the Division works closely with the State and Regional Water Boards on other oil and gas field water issues. The Division collects information regarding produced water, the amount of water injected, and the source of the injection fluid. Our injection database tracks the sources of the water used in the injection process, whether produced from an oil or gas well; produced from a water-source well; obtained from any domestic water system (water district, domestic water well, etc.); extracted from the ocean; obtained as waste from an industrial facility; obtained from a domestic waste disposal or treatment facility; or obtained from any other source or a combination of sources.

10. Which disposal method or methods are used for wastes and wastewater generated by well stimulation treatments?

Statute currently requires reporting of the volume and disposition of fluids produced from a well, but does not require separate reporting for wastes or wastewater from well stimulation treatments. The Division's database currently tracks information on the following disposition methods:

- Evaporation - percolation. (Water is allowed to percolate into the ground and evaporate into the atmosphere, such as in an unlined sump.)
- Evaporation - lined sump. (Water is placed in a lined sump, open tank, or similar container for evaporation into the atmosphere. Solids are either recycled or disposed of using approved methods.)
- Surface water body. (Water is dumped into any surface body of water such as a lake, ocean, pond, stream, river, canal, or irrigation ditch.)
- Sewer system. (Water is placed in a sewage disposal or treatment system.)
- Subsurface injection. (Water is injected deep into the subsurface, typically into depleted oil reservoirs that are known to be sealed within the surrounding geology.)

- Other. (Water is disposed of by another method, such as being turned over to a water disposal contractor.)

11. Is any information available regarding the safety, efficacy, necessity and risk analyses of well stimulation treatments?

Many of the chemicals used for well stimulation require material safety data sheets (MSDS) and are regulated by federal, state, and local agencies. The petroleum industry has extensively studied oilfield safety, and implements policies and procedures to ensure safe operations, including well stimulation operations.

Oil well stimulation plays a vital role in production operations. Once well stimulation warranting additional review or data capture is defined, the Division may capture and review data to track the range of well stimulation treatments. The oil industry and Division implement safety measures to ensure staff safety during stimulation treatments.

12. Is any information available regarding potential risks to occupational or public health and safety associated with well stimulation treatments?

All oilfield operations and chemical handling and use have potential risks. Title 8 of the California Code of Regulations section 3203, requires every employer to develop and implement an effective Injury and Illness Prevention Program (IIPP). The IIPP's purpose is to improve the safety and health in the workplace. The IIPP elements include compliance, hazard assessment, accident/exposure investigation, hazard correction, training, and recordkeeping.

Current articles and papers are consistent in expressing concerns about groundwater contamination, chemical spills, and methane releases. The Department is aware that there are concerns with inhalation issues associated with various oilfield practices. Additionally, operators are required to report any accidents or spills to the Division as well as local authorities.

The Division maintains high standards of safety and hazard awareness as part of its daily operations, both in and out of the oil field. Beginning in late 2013, the Department will begin a comprehensive health and safety review of all workplace conditions, including DOGGR's, and will deliver recommendations to the Director for appropriate actions and improvements.